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**A FORAMINIFERAL FAUNA FROM THE GUAYABAL
FORMATION IN MEXICO**

BY

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fulfillment of the requirements for the degree of Master of Science*

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A THERAPY FOR THE SUBSISTENCE
FORMATION IN MEXICO

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A FORAMINIFERAL FAUNA FROM THE GUAYABAL FORMATION IN MEXICO

BY W. STORRS COLE

INTRODUCTION

CONTENTS

	PAGE
Introduction	5
Acknowledgements	5
Discussion	6
Conclusions	10
Description of Species	10
<i>Angulogerina gallowayi</i>	28
<i>Anomalina umbonata</i>	35
<i>Ammodiscus incertus</i>	10
<i>Amphistegina mexicana</i>	31
<i>Bolivina gracilis</i>	26
<i>Bulimina inflata</i>	25
<i>guayabalensis</i>	24
<i>Cassidulina globosa</i>	32
<i>lomitensis</i> var. <i>mexicana</i>	32
<i>Ceratobulimina declivis</i> var. <i>mexicana</i>	31
<i>Cibicides conoideus</i>	35
<i>pseudowuellerstorfi</i>	36
<i>sassei</i>	35
<i>Clavulina guayabalensis</i>	13
<i>Discocyclina clarki</i>	36
<i>Dentalina cucarensis</i>	14
<i>pulchrella</i>	15
<i>Epistomina bradyi</i>	30
<i>Eponides guayabalensis</i>	29
<i>mexicana</i>	29
<i>Gaudryina gaudryinoides</i>	13
<i>Glandulina radícula</i>	17
<i>Globulina gibba</i>	21
<i>Globigerina apertura</i>	32
<i>bakeri</i>	33
<i>inflata</i>	33
<i>orbiformis</i>	33
<i>topilensis</i>	33
<i>wilsoni</i>	34
<i>Globorotalia crassata</i>	34
<i>crassata</i> var. <i>densa</i>	34
<i>spinulosa</i>	34
<i>Guttulina problema</i>	22
<i>Gyroldina guayabalensis</i>	28
<i>soldanii</i> var. <i>octocamerata</i>	29
<i>Hantkenina longispina</i>	24
<i>Hemicristellaria subaculeata</i> var. <i>glabrata</i>	20

BULLETIN 51

Lenticulina guayabalensis	14
theta	14
Lingulina mexicana	19
Marginulina subbullata	14
Nodosaria consobrina	15
cocoaensis var. mexicana	15
granti	15
harrisi	16
mexicana	16
oolinata	16
wegemanni	17
sp.	17
sp.	17
Nonion micrus	22
florinensis	22
turgidus var. mexicanus	23
umbilicatus var.	23
Operculina bartschi var. plana	23
cushmani	23
Plectofrondicularia mexicana	24
sp.	24
Polymorphina communis	21
Proroporus mexicanus	26
Pullenia quinqueloba	32
Pulvinulinella culter var. mexicana	31
Pyrgo sp.	13
Quinqueloculina hermosa	13
Robulus alato-limbatus	18
articulatus	18
mexicanus	18
mexicanus nudicostatus	19
pseudocultratus	19
pseudovortex	19
Rotalia dorri	29
Schizorthosecos interstitia	9
Siphonina tenuicarinata	30
Textularia mexicana	11
Trochamminoides guayabalensis	11
Trochopora bouei	9
Turbinolia pharetra	9
Uvigerina blanca-costata	26
elongata	26
gladysæ	27
pigmea	27
rippensis	27
Vaginulina costifera	20
legumen var. elegans	21
wrighti	21
Virgulina mexicana	25
Verneuilina palmeræ	12
triquetra	12
Vulvulina cf. spinosa	12

INTRODUCTION

The geologists of the Águila Petroleum Company during their stratigraphic studies of the Mexican formations chose as their type locality, for one of these, a cliff of chocolate colored shales, outcropping twelve kilometers due east of the village of Potrero in the state of Vera Cruz, Mexico. To these shales, they gave the formation name Guayabal, from a small Indian village in the near vicinity of the outcrop.

During the past year, I had the opportunity of visiting this locality and collecting various samples. Studies of the microscopic fauna from these samples, made evident the relationship of the fauna to a small one described already by Cushman¹ from the Moctezuma river. With the exception of *Operculina oliveri* Cushman, all the species mentioned in his paper may be found in the Guayabal type samples.

As a complete paper on the fauna of this formation has not yet appeared or as a type locality has not been designated officially, the purpose of this paper will be an attempt to record a complete enough foraminiferal fauna to make the formation recognizable in well-sections and surface samples and to place a standard name on record for this set of shales.

ACKNOWLEDGEMENTS

I wish to express my appreciation to Mr. Carroll H. Wegemann, chief geologist of the Pan-American Petroleum and Transport Company, for his permission to use Company material together with my personal samples, in the preparation of this paper. Acknowledgement is also due

¹ J. A. Cushman; Bull. Amer. Assoc. Petrol. Geol., vol. 9, No. 2, pp. 298-303, pls. 6-8, 1925.

Mr. Ellis A. Hall and James B. Dorr of the Huasteca Petroleum Company, Tampico, Mexico, for their aid in obtaining necessary samples and data. I am indebted especially to Mr. Dorr, for valuable suggestions and stratigraphic information which he gave very freely while I was in Tampico and during the preparation of this paper. To Professor G. D. Harris of Cornell University, I feel very grateful for advice on this paper and for the use of his excellent laboratory facilities; and may I also mention his inspiring influence while writing this paper. To Katherine V. W. Palmer, to my wife and many others, I am indebted for suggestions, friendly criticisms and advice.

DISCUSSION

The Guayabal formation in its type outcrop is a bank of massive indurated clay of chocolate or reddish brown color. It is about twenty feet in height and extends approximately fifty yards before it is covered with debris. This material breaks with a conchoidal fracture. In the middle of the cliff there is a slightly more arenaceous zone which is better stratified than the clay-shale above and below it. Numerous hard, argillaceous, brown concretions with a carbonate of iron bond are interstratified throughout the deposit, especially in the arenaceous zone. Apparently the beds have suffered little or no deformation and lie in place.

In the wells in the producing region around Cerro Azul, the Guayabal is encountered from forty to one thousand and twenty feet below the surface. In this region above the Guayabal, lie un-named beds of greyish clay-shale which contain numerus *Globigerina* and *Hantkenina alabamensis* Cushman. *Globigerina mexicana* Cushman has a range of about eighty feet directly over the Guayabal which makes it an excellent marker in indicating proximity to the "brown shales." As yet, no name has been proposed for these grey, *Globigerina*-*Hantkenina* indurated clays overly-

ing the Guayabal. For these beds, I propose the name "Chapapote" from the village of Chapapote. This formation outcrops typically on the north bank of the Tuxpam river a hundred yards down stream from the place where the trail from Alamo to Potrero crosses the river at Chapapote. These strata have been known generally to the geologists of Tampico as the Tierra Blanca beds or, in some cases, as the Upper Guayabal beds.

The Guayabal has an average thickness of about fifteen hundred feet, the least thickness from well-sections being three hundred and thirty feet and the greatest fifteen hundred and thirty feet. The original thickness was not probably much more than the average thickness. Little is known of the lateral extent except that the formation thins toward the northwest.

Below the section under discussion, lie other beds of greyish indurated clays also *Globigerina* in character. The species of *Globigerina* is different from that found in the indurated clays above and is easily recognized. This *Globigerina* is often associated with *Hantkenina mexicana* Cushman, although this form is not always present in samples.

So far as is known, the Tantoyuca formation² does not outcrop or occur in wells around Cerro Azul. As the Tertiary stratigraphy of the Tampico Embayment region is studied in greater detail, it becomes evident that the conclusions reached by some of the former workers must be somewhat altered as a result of the accumulation of new information. Thus, I consider *Robulus mexicanus* (Cushman), *Nodosaria mexicana* Cushman and *Anomalina umbonata* Cushman to be the best markers for the Guayabal. These may extend into the Tantoyuca, but if they do this, they occur very rarely in that formation. *Globigerina mexicana* Cushman, as before stated, is one of the best markers

² Ben Belt; Bull. Amer. Assoc. Petrol. Geol., vol. 9, No. 1, p. 143, 1925.

of the basal Chapapote. In this connection, I would like to state that the Chapapote is probably a deep water phase of the Tantoyuca³. Mr. James B. Dorr of the Huasteca Petroleum Company intends to publish in full on the Tantoyuca. His paper has already been published by title in the Bulletin of American Association of Petroleum Geologists. Therefore, I do not care to enter into any further discussion of this formation, except to say that I have seen samples from what is supposed to be the type locality of the Tantoyuca. These samples differ in both their lithologic and faunal character from any of the Tertiary formations under discussion in this paper.

The section that is now considered Guayabal by most of the paleontologists in Tampico, should be divided probably into two formations; the upper, corresponding to the Guayabal as exposed in the type locality; the lower, corresponding to the Tempoal as described by Belt⁴.

I have compared samples from the Tempoal type locality with well-sections particularly in Cerro Azul number fifty-three of the Huasteca Petroleum Company, and a very excellent foraminiferal and lithological correlation may be made. The two formations, if they exist as such,⁵ are evidently related closely; many species being common in samples from both type localities.

In spite of the proof that I have, I hesitate to make a definite statement until field work is done and the actual contact is found exposed and samples examined from each side.

As a tentative section, in order to standardize the Eocene

³ Personal communication from Mr. James B. Dorr.

⁴ Ben Belt; Bull. Amer. Assoc. Petrol. Geol., vol. 9, No. 1, p. 143, 1925.

⁵ Note: Mr. Dorr of the Huasteca Petroleum Company, considers that the differences are not sufficient to warrant the splitting of these brown shales into two formations. However, the author feels that until more field evidence is offered, it is better to distinguish one from the other as the two can be recognized faunally, although lithologically they are very similar.

of the so-called Southern Field district (the producing region around Cerro Azul) I would like to propose the following:

GENERAL AGE	NAME	THICKNESS	CHARACTER
Lower Oligocene	Alazan	?	See Dumble ⁶ and Vaughan ⁷
	Chapapote	40' to 1020'±	Grey indurated clays containing <i>Hantkenina alabamensis</i> and <i>Globigerina mexicana</i>
	Guayabal	1000'±	Chocolate indurated clays and sandstones containing <i>Nodosaria mexicana</i> and <i>Robulus mexicanus</i>
Eocene	Tempoal	500'±	Grey to dark colored sandy shales and thin sandstones containing <i>Virgulina</i> , <i>Gyroclidina</i> and <i>Nonion</i> abundantly
	Un-named	200'±	Globigerina shales with <i>Hantkenina mexicana</i>
	Chicontepec	? 1000' ?	See Belt ⁸

As the Guayabal contains the genus *Hantkenina* in some abundance, the inference may be drawn at once that it is either Upper Middle or Upper Eocene. The presence of a *Discocyclus* which I have referred to *D. clarki* Cushman, suggests a correlation with the Meganos group of Clark of the west coast. Cushman has reported *Eponides mexicana* (Cushman) from deposits of Claiborne age on the Gulf Coast. However, the best correlation to date has been made by two species of bryozoa which Dr. Bassler informs me are *Schizorthosecos interstitia* Lea and *Trochopora bouei* Lea. Also there is found one species of coral *Turbinolia pharetra* Lea. These forms are typically confined to the

⁶ E. T. Dumble; Calif. Acad. of Sci. Proc., vol. 8, pp. 141-144, 1918.

⁷ T. W. Vaughan; Bull. Geol. Soc. of Amer., vol. 35, No. 4, pp. 731-732, 1924.

⁸ Ben Belt; Bull. Amer. Assoc. Petrol. Geol., vol. 9, No. 1, p. 142, 1925.

Upper Claiborne and Lower Jackson. I am inclined to consider the Guayabal as Claiborne in age rather than Jackson as the presence of these forms and of *D. clarki* and *Eponides mexicana* seem to warrant this conclusion.

In a future paper, I hope to describe a few mollusks found in the Guayabal and by means of these to obtain a more definite and accurate correlation.

CONCLUSIONS

The Guayabal may be recognized both by lithology and faunal characters as a separate and distinct formation of probable Upper Claiborne age. There is a close faunal connection evidently between the Guayabal and the underlying Tempoal, but the writer believes that the two formations are separate and distinct. However, should more field work prove that the relationship is more definite, the name Tempoal must take precedence for the middle Eocene formations.

Until the time comes when more is known of the Mexican Eocene section, the above suggested classification may be adhered to as the best that can be presented with the limited knowledge we now have.

There can be no question as to the Chapapote being a separate formation as the faunal and lithologic break is sharp with the underlying Guayabal. However, the Chapapote represents probably a deep water phase⁹ of the Tanto-yuca. As such, it deserves a separate name to designate it.

DESCRIPTION OF SPECIES

Family AMMODISCIDÆ

Genus AMMODISCUS Reuss, 1861

Ammodiscus incertus (d'Orbigny)

Pl. 4, fig. 17.

Operculina incertus d'Orbigny, Foram. Cuba, p. 71, pl. 6, figs. 16, 17, 1839.

Ammodiscus incertus H. B. Brady, Rept. Challenger, Zool., vol. 9, p. 330, pl. 38, figs. 1-3, 1884.

Ammodiscus incertus Plummer, Bull. Univ. Texas, No. 2644, pp. 63-64, pl. 13, figs. 1a-d, 1926.

⁹ Personal communication from Mr. J. B. Dorr.

Specimens of this species are very rarely encountered in the Guayabal. The specimens are distorted generally. Mrs. Plummer in her discussion of Midway Foraminifera found also that the majority of her specimens had suffered distortion. This species is more common in the Chapapote beds where more perfect and typical specimens are found.

Family LITUOLIDÆ

Subfamily HAPLOPHRAGMIINÆ

Genus TROCHAMMINOIDES Cushman, 1910

Trochamminoides guayabalensis n. sp.

Pl. 4, fig. 14.

Test compressed, close-coiled, inequilateral, about five chambers in the last formed coil; sutures distinct; wall finely arenaceous, smoothly finished.

Diameter 0.42 mm. Thickness 0.13 mm.

This species is related very closely to *Trochamminoides velascoensis* Cushman, but differs in having fewer chambers and a more compressed form. It is difficult sometimes to tell these two species apart. However, from the study of a great number of both, I believe the Guayabal species is distinct. *T. guayabalensis* has a very long range in the Tertiary of Mexico.

Family TEXTULARIIDÆ

Subfamily SPIROPLECTAMMININÆ

Genus TEXTULARIA DeFrance, 1824

Textularia mexicana n. sp.

Pl. 5, fig. 3.

Test small, elongate, thickest in the middle, thence thinning gradually to the periphery; well preserved specimens with a slight keel; chambers wider than high, finely arenaceous, smooth; sutures distinct, covered by a coarse, arenaceous layer which joins in the center, forming a prominent ridge.

Length 0.25-0.50 mm.

This is a small but constant and characteristic species. The coarse layers forming the ridge and covering the sutures are generally black in color. By this character, this species is distinguished easily.

Genus VULVULINA d'Orbigny, 1826

Vulvulina cf. spinosa Cushman

Pl. 1, fig. 10.

Vulvulina spinosa Cushman, Cont. Cushman Lab. Foram. Res., vol. 3, No. 2, p. 3, pl. 23, fig. 1, 1927.

One specimen which may be this species, was found in the top sample from the Guayabal type locality. Only one chamber of the uni-serial portion is present. The initial chambers resemble those of Cushman's species very closely. There are young specimens of *V. spinosa* in the formation above which agree very closely with this one.

V. spinosa is a relatively common form in the Chapapote formation, but very rare in the Guayabal.

Family VERNEUILINIDÆ

Genus VERNEUILINA d'Orbigny, 1840

Verneuilina palmeræ n. sp.

Pl. 2, fig. 31.

Test pyramidal, roughly three-sided, the sides convex; tri-serial throughout; coarsely arenaceous, but only slightly roughened; chambers inflated; aperture a curved slit at the base of the last chamber.

Length 0.70 mm.

This is a very rare species, occurring in only one sample. It is named in honor of Dr. Katherine V. W. Palmer.

Verneuilina aff. triquetra (Munster)

Pl. 4, fig. 18.

Textularia triquetra Munster, Neues Jahrb., p. 384, pl. 3, fig. 19, 1838.

Verneuilina triquetra H. B. Brady, Rept. Challenger, Zool., vol. 9, p. 383, pl. 47, figs. 18-20, 1884.

Verneuilina triquetra Chapman, Pal. Bull. 11, New Zeal. Geol. Sur. p. 31, pl. 6, fig. 13, 1926.

A few specimens which I have placed with hesitancy under this species occur in the Guayabal. It is a very rare form.

Genus GAUDRYINA d'Orbigny, 1839

Gaudryina gaudryinoides (Fornasini)

Pl. 2, fig. 30.

Clavulina gaudryinoides Fornasini, Bull. Soc. Geol. Ital., vol. 4, p. 7, tav. 6, figs. 3-9, 1885.

Clavulina gaudryinoides Halkyard, Mem. Proc. Manchester Lit. Phil. Soc., vol. 62, No. 6, p. 46, pl. 3, figs. 1-3, 1919.

Specimens taken from the top sample agree in every detail with Halkyard's figures. Therefore, I am referring my specimens to the same species. There are other forms which exhibit more strongly the bi-serial character, but it is evident that they should all be considered under the same species as there are all gradations.

Genus CLAVULINA d'Orbigny, 1826

Clavulina guayabalensis n. sp.

Pl. 1, fig. 11.

Test elongate, triangular in section, slightly tricarinate; tri-serial portion short, expanding rapidly to form the uni-serial portion, the sides of which are parallel; uni-serial portion composed of three to five chambers; wall composed of relatively coarse sand grains with a large amount of cement, giving a smooth finish to the test; sutures in most specimens very indistinct; aperture terminal, round.

Length 1.1 mm.

This species is relatively common in the bottom samples from the type locality. It is close to *C. angularis* d'Orbigny, but differs in several respects.

Family MILIOLIDÆ

Genus QUINQUELOCULINA d'Orbigny, 1826

Quinqueloculina hermosa n. sp.

Pl. 2, figs. 28, 29.

Test elongate, oval; chambers narrow, of uniform width; periphery rounded; aperture produced, rounded with a simple tooth; sutures distinct, surface smooth, polished.

Length 0.40-0.60 mm.

A rare species of small value because of its rarity.

Genus PYRGO DeFrance, 1824

Pyrgo sp.

Pl. 4, fig. 15.

A single species is here figured for future reference. Without a more complete suite it is hopeless to place this specifically.

Family LAGENIDÆ

Subfamily NODOSARIINÆ

Genus LENTICULINA Lamarck, 1804

Lenticulina guayabalensis n. sp.

Pl. 1, figs. 3, 4.

Test closely coiled in young specimens; in the adult, a portion of the central area becomes visible due to the shortening of the final chambers which fail to cover the preceding volution entirely; sutures distinct, between the last formed chambers, generally depressed slightly; 9-11 chambers in the final coil; periphery relatively sharp; central area with a knob of clear shell material; aperture produced, radiate.

Diameter 0.50-0.75 mm.

Lenticulina theta n. sp.

Pl. 1, fig. 17.

Test closely coiled, composed of 6-8 chambers which gradually increase in size; sutures slightly limbate, curved, flush with the surface of the shell; periphery subangulate, not keeled; apertural face produced, triangular, tapering toward the apertural which is slightly produced, radiate.

Diameter 0.50-0.66 mm.

Genus MARGINULINA d'Orbigny, 1826

Marginulina subbullata Hantken

Pl. 5, fig. 10.

Marginulina subbullata Hantken, A. Magy. Kir. foldt. int. Evkon., vol. 4, p. 39, pl. 4, figs. 9, 10, pl. 5, fig. 9, 1875 (1876).

Marginulina subbullata Cushman, Calif. Acad. of Sci. Proc., 4th ser., vol. 16, No. 8, p. 216, pl. 13, fig. 11, 1927.

In the Guayabal, only one specimen was found which may be referred to this species. It is very similar to the form found in the Alazan and Chapapote referred by Cushman to Hantken species. In Mexico it is not common in any formation.

Genus DENTALINA d'Orbigny, 1826

Dentalina cucarensis n. sp.

Pl. 3, fig. 14.

Test elongate, arcuate; chambers gradually enlarging, inflated; sutures oblique, of clear shell material, depressed; apertural terminal radiate.

Length 0.81 mm.

Dentalina pulchrella n. sp.

Pl. 3, fig. 1.

Test small, curved, composed of about 6 rapidly enlarging chambers, the last two comprising over half the test; wall thin, smooth, clear; sutures becoming more depressed toward the apertural end; aperture small, terminal, round, radiate.

Length 0.56 mm.

Genus NODOSARIA Lamarck, 1812**Nodosaria consobrina** d'Orbigny

Pl. 3, fig. 5.

Dentalina consobrina (d'Orbigny), Foram. Foss. Bass. Tert. Vienne, p. 46, pl. 2, figs. 1-3, 1846.

Nodosaria consobrina Cushman and Hanna, Trans. San Diego Soc. Nat. Hist., vol. 5, No. 4, p. 52, pl. 4, figs. 7, 8, 1927.

In the bottom samples from the type locality this form is abundant. It is easily recognized by its smooth, inflated chambers and initial spine. It is a short-ranged species. It has also been recorded from the Eocene at Coalinga and San Diego, California. Perfect specimens are seldom found, due to the ease with which this form breaks at the sutures.

Nodosaria cocoaensis Cushman var. **mexicana** n. var. Pl. 3, fig. 9.

Test differing from the original in the greater size and slightly different apertural end which is not so produced.

Length up to 4.5 mm.

This may represent a new species, but not enough differences were observed to warrant it being so considered. Except for the differences noted above, this species agrees with Cushman's figures and description of general shape, character of shell material and sutures. The megalospheric form of this species has a large subglobular, initial chamber with a small spine. Otherwise, it is like the microspheric form. *N. cocoaensis* occurs in the Alazan but may be distinguished easily from the Guayabal variety.

Nodosaria cf. **N. granti** Plummer

Pl. 3, fig. 15.

Nodosaria granti Plummer, Bull. Univ. Texas, No. 2644, p. 77, pl. 4, figs. 9a-b, 1926.

Test similar to *Nodosaria granti* but without the initial spine. Only one specimen was found. Therefore, the variation which Mrs. Plummer speaks of could not be observed.

As it agrees better with this species, I am placing it there temporarily until more material can be studied.

Nodosaria harrisi n. sp.

Pl. 3, fig. 2.

Test elongate, slender, somewhat arcuate, composed of 7-10 subglobular chambers which gradually increase in size after the first three; sutures compressed, composed of clearer shell material; shell generally brown in color, smooth, glistening; aperture terminal, phialine.

Length 0.74 mm.

This species is sparingly present. In the other Mexican Tertiary formations, there are specimens very close to this species. It probably has a very extended vertical range. Evidently it is related closely to *Nodosaria jacksonensis* Cushman and Applin. It differs from this species in the initial chambers mainly and also in size. For stratigraphic reasons, I have made this a new species as there is a form in the beds above the Guayabal, which agrees more closely with the true *N. jacksonensis*. This species is named in honor of Professor G. D. Harris.

Nodosaria mexicana Cushman

Pl. 3, figs. 3, 4.

Nodosaria mexicana Cushman, Cont. Cushman Lab. Foram. Res., vol. 1, pt. 1, p. 5, pl. 1, fig. 3, 4, 1925.

Cushman's figures and description of this species, represent evidently broken specimens, as the adult form adds from three to five large, rounding chambers after the ridged ones. While most of the specimens compare exactly with his figures and discussion, a few well developed and adult forms may be found, which have the final chambers.

This species is listed as coming from the Tantoyuca formation. If it occurs in this formation, it is either very rare or is due to contamination with re-worked material. With *Robulus mexicanus*, this species is the most abundant and characteristic of the Guayabal formation.

Nodosaria oolinata n. sp.

Pl. 3, fig. 16.

Test slender, elongate, arcuate, composed of numerous

gradually enlarging, slightly inflated chambers; sutures distinct, depressed, of clear shell material; chambers ornamented by having a few, very indistinct, spinous processes on the posterior side; aperture very slightly produced.

Length 0.70 mm.

Nodosaria wegemanni n. sp.

Pl. 3, fig. 8.

Test long, slender, slightly arcuate, gradually enlarging; chambers 10-12 in number, slightly inflated, ornamented by fine but distinctive costæ that follow the entire length of the test; sutures moderately constricted toward the apertural end, very slightly, if at all constricted between the initial chamber; aperture not observed.

Length up to 2 mm.

This is a rare species, only a few specimens being found in the upper sample. It is named in honor of Mr. Carroll H. Wegemann, chief geologist of the Pan-American Petroleum and Transport Company.

Nodosaria sp.

Pl. 3, fig. 17.

In the middle sample, there was found a specimen of a *Nodosaria* showing four chambers. I am figuring it in the hope that more specimens may become available, so that it can be described specifically.

Nodosaria sp.

Pl. 1, fig. 21.

This is a broken specimen, showing the last four chambers. It occurred in the upper sample from the type locality. Without a complete specimen or more fragments, this cannot be placed specifically.

Genus GLANDULINA d'Orbigny, 1826

Glandulina radícula (Linnæus)

Pl. 3, fig. 6, 7.

Nautilus radícula Linnæus, Syst. Nat., 12th ed., pp. 285, 1164, 1767; Gmelin's ed. 13, vol. 1, pt. 6, p. 3373, No. 18, 1788.

Nodosaria radícula d'Orbigny, Ann. Sci. Nat., vol. 7, p. 252, No. 3, Modele No. 1, 1826.

Nodosaria radícula Cushman, Bull. U. S. Nat. Mus., No. 100, vol. 4, p. 190, pl. 34, fig. 4, 1919.

Nodosaria radícula Plummer, Bull. Univ. Texas, No. 2644, p. 77, pl. 4, figs. 9a, b, 1926.

The Guayabal forms seem very typical of this species. There seems to be considerable range as to the amount of constriction the sutures may take. On some specimens, there is little or no constriction of sutures toward the apertural end. On others, it is very marked, particularly in the final suture.

Genus ROBULUS Montfort, 1808

Robulus alato-limbatus (Gumbel)

Pl. 4, fig. 1.

Robulina alato-limbata Gumbel, Abhandl. Kon. Bay. Akad. Wiss., Munchen, Cl. 2, vol. 10, p. 641, pl. 2, figs. 70a, b, (1868 [1870]).

Cristellaria alato-limbata Cushman and Applin, Bull. Amer. Assoc. Petrol. Geol., vol. 10, No. 9, pp. 171, 172, pl. 8, figs. 8a, b, 1926.

Numerous specimens which resemble very closely Gumbel's species from the Eocene of Europe are found throughout the Guayabal. It is a very common form with a long range, probably extending into the formations above.

Robulus articulatus (Reuss)

Pl. 1, fig. 18.

Robulina articulata Reuss, Sitz, Akad. Wiss., Wien, vol. 48, p. 53, pl. 5, fig. 62, 1863.

Cristellaria articulata H. B. Brady, Rept. Challenger, Zool., vol. 9, p. 547, pl. 69, figs. 10-12, 1884.

The Guayabal specimens appear similar to the figures and descriptions generally given for this species. While it is comparatively large and easily recognized, it is rare at all horizons.

Robulus mexicanus (Cushman)

Pl. 1, fig. 20

Cristellaria mexicana Cushman, Bull. Amer. Assoc. Petrol. Geol., vol. 9, No. 2, p. 299, pl. 7, fig. 1, 2, March, April, 1925.

Robulus mexicanus (Cushman), Jour. of Pal., vol. 1, No. 2, p. 151, pl. 23, fig. 8, 1927.

This species is particularly well developed, being one of the most abundant and characteristic of the formation, especially in the upper and middle parts of the well-sections. Numerous specimens were compared not only with Cushman's description and plates, but also with actual specimens from the *Operculina oliveri* zone of the Moctezuma river. In all cases, they appear to be similar.

The variety *R. mexicanus nudicostatus* Cushman and Hanna described from the Eocene of California occurs commonly at all horizons. There are, however, all gradations in this species. One form of *R. mexicanus* is very uncoiled, typically exhibiting three to five chambers in the uncoiled portion. All of these forms are confined typically to the Guayabal, but *R. m. nudicostatus* extends into the Tempoal.

***Robulus pseudovortex* n. sp.**

Pl. 1, fig. 12.

Test close-coiled, biconvex, umbonate, 6 chambers composing the last formed coil; chambers elongate, curved, enlarging as they approach the periphery; sutures raised, whirling out from the center umbo; peripheral margin acute, but not carinate; last septal face small, triangular, the aperture taking up most of the face.

Diameter 0.70 mm.

While this species adopted a very similar form of coiling to that of *R. vortex*, it can be recognized by its fewer chambers which are very much enlarged upon reaching the periphery.

***Robulus pseudocultratus*, n. sp.**

Pl. 1, fig. 5.

Test relatively small, closely coiled, with a wide, clear keel, eight chambers forming the final volution; sutures distinct, of clear shell material, widening as they approach the keel, generally flush with the surface of the test; umbilical area relatively large, filled with clear shell material; aperture radiate.

Diameter 0.58 mm.

This species belongs to the general group of specimens referred to *C. cultrata*, but differs from that in its much smaller size, less raised sutures, and larger, more distinct umbilical area. It is rare at all horizons.

Genus LINGULINA d'Orbigny, 1826

***Lingulina mexicana* n. sp.**

Pl. 1, fig. 9.

Test broadly ovate, nearly as broad as long, composed

of about five chambers, the last making at least half of the individual; sutures indistinct; shell thick, highly polished; aperture elongate, terminal, enclosed by two rather prominent lips.

Length 0.63 mm. Width 0.59 mm. Thickness 0.33 mm.

This is a rare species. It has no stratigraphic value on account of its rarity.

Genus HEMICRISTELLARIA Stache, 1864

Hemicristellaria subaculeata (Cushman), var. *glabrata* (Cushman)

Cristellaria subaculeata Cushman, var. *glabrata* Cushman, Bull. U. S. Nat. Mus., No. 104, pt. 4, p. 124, pl. 32, fig. 4, pl. 33, figs. 2, 3, pl. 34, fig. 3, 1923.

Cristellaria subaculeata Cushman, var. *glabrata* Cushman and Hanna, Calif. Acad. of Sci. Proc., vol. 16, No. 8, p. 219, 1927.

Specimens that agree very closely with this variety occur sparingly in the Guayabal. The only difference noted was that the Guayabal variety does not have as strong a development of spines on the periphery.

This form may be a new variety but as there is so much variation in this type of foraminifera, it was considered best to refer it to the described form, noting the differences.

Cushman has found what he considers is this form near Coalinga, California. There, it was associated with the typical form for the species. The typical form does not seem to occur in the Guayabal.

Genus VAGINULINA d'Orbigny, 1826

Vaginulina costifera n. sp.

Pl. 2, fig. 16.

Test relatively small, flattened, curved initially, keeled, strongly costate; costæ twelve in number, running the entire length of the test; sutures very indistinct; about three chambers making up the linear portion; aperture produced, radiate.

Length 0.80 mm.

This is a striking species, occurring rarely in the samples from the middle of the type outcrop.

Vaginulina legumen (Linnæus), var. **elegans** d'Orbigny

Pl. 3, figs. 10, 11.

Vaginulina elegans d'Orbigny, Ann. Sci. Nat., vol. 7, p. 257.*Vaginulina legumen* (Linnæus) var. *elegans* Fornasini, Bull. Soc. Geol. Ital., vol. 5, p. 25, pl. 1, figs. 1 (?), 2, 8, 1886.*Vaginulina legumen* (Linnæus), var. *elegans* Cushman, Bull. U. S. Nat. Mus., No. 100, vol. 4, p. 258, pl. 41, fig. 4, 1919.

Inasmuch as the original figure was not available, I am referring the Guayabal specimens to this type, provisionally. It agrees very closely with both Cushman's Vicksburg figure and Mrs. Plummer's Midway.

It occurred in both the lower and middle samples from the type locality, but was very rare.

Vaginulina wrighti n. sp.

Pl. 3, fig. 13.

Test slightly compressed laterally, composed of about eight chambers; sutures distinct, oblique; wall smooth, polished; chambers gradually enlarging, aperture produced.

Length 0.58 mm.

This is a very rare species and is named in honor of Dr. Albert H. Wright.

Family POLYMORPHINÆ**Subfamily POLYMORPHININÆ****Genus POLYMORPHINA** d'Orbigny, 1826**Polymorphina communis** d'Orbigny

Pl. 1, fig. 6.

Polymorphina (Guttulina) *communis* d'Orbigny, Ann. Sci. Nat., vol. 7, p. 266, No. 15, pl. 12, figs. 1-4, 1826.*Polymorphina communis* d'Orbigny, Foram. Foss. Bass. Tert. Vienne, p. 224, pl. 13, figs. 6-8, 1846.*Polymorphina communis* Plummer, Bull. Univ. Texas, No. 2644, pp. 123-124, pl. 6, figs. 12a, b, 1926.

This species from the Guayabal is very similar to figures generally given for this type of *Polymorphina*. It is a rather common species in the bottom samples from the type locality, but occurs rarely in the others.

Genus GLOBULINA d'Orbigny, 1826**Globulina gibba** d'Orbigny

Pl. 4, fig. 16.

Polymorphina subcordiformia vel *oviformia* Soldani, Testaceographiae, vol. 1, pt. 2, p. 114, pl. 113, fig. 22, C. etc. 1791.*Polymorphina* (*Globulina*) *gibba* d'Orbigny, Ann. Sci. Nat., vol. 7, p. 266, No. 20, Modele No. 63, 1826.

Globulina gibba d'Orbigny, Foram. Foss. Bass. Tert. Vienne, p. 227, pl. 13, figs. 13, 14, 1846.
Polymorphina gibba Cushman, Bull. U. S. Nat. Mus. No. 104, pt. 4, p. 150, 1923.

Occasionally, specimens are found which may be referred to this species. They are very rare and probably of no stratigraphic importance.

Genus GUTTULINA d'Orbigny, 1826

Guttulina problema d'Orbigny

Pl. 4, fig. 20.

Polymorphina (Guttulina) problema d'Orbigny, Ann. Sci. Nat., vol. 7, p. 266, No. 14, Modeles No. 61, 1826.

Polymorphina problema Cushman, U. S. Geol. Survey, Prof. Paper, No. 133, p. 33, pl. 5, fig. 6, 1923.

Specimens that agree in every respect with d'Orbigny's figures and also those given for recent forms, were found in the middle sample from the Guayabal locality. It is a very rare form and therefore of no importance.

Family NONIONIDÆ

Genus NONION Montfort, 1808

Nonion micrus n. sp.

Pl. 5, fig. 12.

Test small, compressed, strongly umbilicate, slightly lobate; sutures depressed, 6-8 chambers composing the last formed coil; shell wall very thin, rather coarsely perforate; aperture at the base of the last chamber, large.

Diameter 0.2-0.3 mm. Thickness 0.1 mm.

This small *Nonion* occurs rather frequently at all horizons in the Guayabal. It ranges also into the Chapapote. Its compressed, thin walled lobate chambers make it easy to recognize.

Nonion florinensis n. sp.

Pl. 4, fig. 4.

Test small, compressed, considerably longer than wide, composed of nine chambers in the last formed volution; sutures distinct, evenly curved; periphery broadly rounded; umbilical area often exposed showing the inner ends of the earlier chambers; wall smooth; aperture a small arched opening at the base of the last septal face.

Diameter 0.21 mm. Thickness 0.10 mm.

This small species occurs frequently associated with the other two species of *Nonion*. It is very similar to *Nonion hantkeri* (Cushman and Applin) from the Upper Eocene of Texas but differs in having a constantly, smaller number of chambers and different shape. As far as is known, this species is restricted to the Guayabal.

Nonion turgidus (Williamson) var. ***mexicanus*** n. var. Pl. 2, fig. 12.

The variety differs from the original in the less embracing character of the last chamber, and the last septal face being not so large as in the typical *turgidus*.

Length 0.25-0.35 mm.

The Mexican species are very close, but should be separated from the original.

Nonion cf. umbilicatus (Montagu) var.

Pl. 5, fig. 6.

Nautilus umbilicatus Montagu, Test. Brit., p. 191, 1803.

Occasional specimens of *Nonion* are found in the Guayabal samples which I am referring to this species until more work is done to separate the various specimens which are considered *N. umbilicatus*.

Family NUMMULITIDÆ

Genus OPERCULINA d'Orbigny, 1826

Operculina cushmani n. sp.

Pl. 2, fig. 14.

Test complanate, compressed, composed usually of about three coils, the last with twenty to twenty-two chambers which are very long and narrow; sutures very slightly raised with a tendency to bead, especially near the center, gently curved, meeting in the center on some specimens to form a very slight umbo which is never very prominent.

Length 2.5 mm.

Of the described *Operculinas*, its nearest representative is *O. ocalana*. It differs from this in its smaller size, less raised sutures and un-thickened periphery.

Operculina bartschi Cushman, var. ***plana*** Cushman

Pl. 2, fig. 21.

Operculina bartschi Cushman, var. *plana* Cushman, Carnegie Inst., vol. 21, p. 50, pl. 17, figs. 5, 6, 1924.

This form is identical with the recent species described

by Cushman. This is the first record of this *Operculina* in the fossil state. It is rare in its occurrence and of small value as a horizon marker.

Family HETEROHELICIDÆ

Subfamily PLECTOFRONDICULARINÆ

Genus PLECTOFRONDICULARIA Liebus, 1903

Plectofrondicularia mexicana Cushman

Plectofrondicularia mexicana Cushman, Cont. Cushman's Lab. Foram. Res., vol. 1, pt. 4, p. 88, pl. 13, figs. 5a-c, 1926.

This is a beautiful species, occurring most abundantly in the sample from the middle zone of the type locality with *Hantkenina longispina* Cushman.

Plectofrondicularia sp.

Pl. 2, fig. 10

Specimens referable to this genus, occur sparingly in the middle sample from the type locality. As a complete specimen was not found, it was considered better not to place this form specifically. It is here figured for future reference.

Family HANTKENINIDÆ

Genus HANTKENINA Cushman, 1924

Hantkenina longispina Cushman

Pl. 4, fig. 7.

Hantkenina longispina Cushman, Proc. U. S. Nat. Mus., vol. 66, p. 2, pl. 2, fig. 4, 1924.

Hantkenina longispina Cushman, Bull. Amer. Assoc. Petrol. Geol., vol. 9, No. 2, March-April, p. 299, pl. 7, fig. 3, 1925.

In the sample taken at the middle horizon at the type outcrop, this species occurs relatively abundant. In view of the fact of its comparative rarity, in all the samples examined, and its fragility, it is valueless as a marker in well sections.

Family BULIMINIDÆ

Subfamily BULIMININÆ

Genus BULIMINA d'Orbigny, 1826

Bulimina guayabalensis n. sp.

Pl. 1, figs. 1, 2.

Test compact, ovate, broadest near the apertural end, chambers few, large, inflated, smooth; sutures strongly de-

pressed aperturally, very slightly depressed in the initial chambers; aperture long, narrow.

Length 0.42 mm. Width 0.26 mm.

Cushman has figured already this species under *Bulimina* sp. in his Moctezuma paper and also a species very similar to this, in his discussion of the Texas Jackson Foraminifera. It belongs to the general group of *Bulimina pupoides* d'Orbigny, but differs in the fewer number of chambers, more compact form and slightly different arrangement of chambers.

***Bulimina inflata* Seguenza**

Pl. 3, fig. 12.

Bulimina inflata Seguenza, Atti. Accad. Givenia Sci. Nat., ser. 2, vol. 18, p. 109, pl. I, fig. 10.

Bulimina inflata H. B. Brady, Rept. Challenger, Zool., vol. 9, p. 406, pl. 51, figs. 10-13, 1884.

Bulimina inflata Cushman, Bull. U. S. Nat. Mus., No. 100, vol. 4, p. 160, pl. 31, fig. 6, 1921.

There are specimens from the Guayabal which are very similar in shape and ornamentation to that of Seguenza's. For the present, it is considered better to refer it to this species.

Subfamily VIRGULININÆ

Genus VIRGULINA d'Orbigny, 1826

***Virgulina mexicana* n. sp.**

Pl. 5, fig. 14.

Test small, compressed, axis slightly twisted; tri-serial portion very short; bi-serial chambers elongate, bolivine; sutures distinct, slightly depressed; wall smooth, very finely perforate; aperture comma shaped at the end of the last chamber.

Length 0.30-0.55 mm.

This species is very close, if not identical with one Cushman figured in his Byram marl paper as *Virgulina* sp. It is characteristic of both the Guayabal and Tempoal, but its range is restricted to these formations. At some horizons it is very abundant.

Genus BOLIVINA d'Orbigny, 1839**Bolivina gracilis** Cushman and Applin

Pl. 5, fig. 13.

Bolivina gracilis Cushman and Applin, Bull. Amer. Assoc. Petrol. Geol., vol. 10, No. 2, p. 167, pl. 7, figs. 1, 2, 1926.

There are small specimens of *Bolivina* in the Guayabal, that compare closely with Cushman's and Applin's description and figures. I am referring my specimens to this species with some hesitancy. They occur rarely and are easily overlooked. The best specimens came from the bottom sample from the Guayabal locality.

Genus PROROPORUS Ehrenberg, 1844**Proroporus mexicanus** n. sp.

Pl. 1, fig. 19.

Test elongate, triangular, thickest in the middle, thinning evenly to the periphery, which is serrate, the serrations being in the shape of a thin keel which is indented at each suture; sutures distinct, depressed, the chamber wall between the sutures being white and raised; aperture terminal, large.

Length 0.93 mm.

This is a rare but peculiar species from the top sample at the type locality.

Subfamily UVIGERININÆ**Genus UVIGERINA d'Orbigny, 1826****Uvigerina blanca-costata** n. sp.

Pl. 2, fig. 11.

Test relatively small, later portion with the chambers somewhat loosely arranged, periphery in this portion, lobulate; chambers few, inflated, especially the later ones; wall ornamented with longitudinal costæ, the costæ not confluent with those on the chambers above or below; in the early portion there is the tendency of the costæ to break into spines; aperture a tapering, cylindrical neck.

Length 0.33 mm.

This is a relatively rare form.

Uvigerina elongata n. sp.

Pl. 4, figs. 3, 4.

Test small, elongate, composed of a compact, early portion, with a tendency for the final chamber to be added uni-

serially; surface slightly hispid; aperture an elongate neck and with a narrow, rimmed phialine neck.

Length 0.35-0.40 mm.

This species is nearest *Uvigerina ampullacea* H. B. Brady, but differs in having the uni-serial portion not so strongly developed and not as strongly hispid. It is also much smaller in size and has a shorter neck.

Uvigerina gladysæ n. sp.

Pl. 5, fig. 11.

Test minute, about as broad as long, apertural end the largest; chambers few, strongly inflated; sutures distinct; the initial chambers having 3-5 short spines, test otherwise without ornamentation; aperture circular on the end of a short neck.

Length 0.15 mm.

It is fairly common in most samples but easily overlooked on account of its small size.

Uvigerina pigmea d'Orbigny

Pl. 5, fig. 9.

Uvigerina pigmea d'Orbigny, Ann. Sci. Nat. vol. 7, p. 269, pl. 12, figs. 8, 9, 1826.

Uvigerina pygmaea d'Orbigny, Foram. Foss. Bass. Tert. Vienne, p. 190, pl. 11, figs. 25, 26, 1846.

Specimens that are similar in type to the figures given in the Vienna Basin monograph are found in the Guayabal samples from the type locality. No specimen from the Guayabal gives any indication of grading into the type of *U. pigmea* as represented by the figure in the Annales des Sciences Naturelles, which should probably be considered a separate species.

Uvigerina rippensis n. sp.

Pl. 2, fig. 17.

Test of medium size for the genus, elongate, fusiform; periphery slightly lobulate; chambers rather few, inflated, evenly rounded; sutures slightly depressed; central chambers ornamented with coarse, prominent, longitudinal costæ which break into spines on either end of the test; apertural end with a short, cylindrical neck and phialine lip.

Length 0.75 mm.

This is a very characteristic species, found only in the middle sample. It is easily recognized by the tuberculate apertural and initial ends with the coarse costæ between.

Genus ANGULGERINA Cushman, 1927

Angulogerina gallowayi n. sp.

Pl. 5, fig. 8.

Test elongate, tapering toward either end, composed of numerous chambers, three making each whorl, with the exception of the last chamber which is added uni-serially; chambers are so compressed as to make a tri-facial test; chambers smooth, perforate; some specimens having a slight keel along the angles; aperture elongate, with a phialine lip.

Length 0.2-0.4 mm.

This species is close to *Angulogerina angulosa* (Williamson), but differs in size and ornamentation. It is without doubt a distinct species and easily recognized in spite of its small form. It is abundant at some horizons, especially the middle sample from the type locality. This species is named in honor of Dr. J. J. Galloway of Columbia University.

Family ROTALIIDÆ

Subfamily DISCORBISINÆ

Genus GYROIDINA d'Orbigny, 1826

Gyroidina guayabalensis n. sp.

Pl. 2, figs. 25, 26, 27.

Test plano-convex, ventral side strongly convex; 8-9 chambers forming the last volution, deeply umbilicate; sutures distinct, not raised; chambers of the last formed coil appearing very narrow on the dorsal side; a distinct depression between the last formed coil and the remaining coils on the dorsal side; aperture an elongate slit on the center of the inner edge of the last face.

Diameter 0.40 mm. Thickness 0.27 mm.

This species differs from *G. soldanii* var. *octocamerata* in its larger size, more angulated margin, flush sutures and narrower, more elongated chambers of the last coil.

Gyroidina soldanii d'Orbigny var. **octocamerata** Cushman and Hanna Pl. 2, figs. 22, 23, 24.

Gyroidina soldanii d'Orbigny var. *octocamerata* Cushman and Hanna, Calif. Acad. of Sci. Proc., 4th ser., vol. 16, No. 8, p. 223, pl. 14, fig. 16-18, 1927.

This species described from the Eocene of California is rather common in many of the Guayabal samples.

Subfamily ROTALIINÆ

Genus EPONIDES Montfort, 1808

Eponides guayabalensis n. sp. Pl. 2, figs. 18, 19, 20

Test unequally bi-convex, composed of three and one-half coils, the ventral side more convex than the dorsal, umbilicate; periphery angulate, subcarinate, 12-14 chambers in the last volution; sutures on both dorsal and ventral side nearly straight, the ventral ones forming a ring of clear shell material around the umbilicus; aperture a low arched slit between the umbilicus and periphery.

Diameter 0.82 mm. Thickness 0.52 mm.

In general aspect, this species resembles *E. mexicana* but with its greater number of coils and chambers, together with the nearly straight, dorsal sutures and large size, it is easily recognizable. It is a characteristic and abundant form in the Guayabal and should be an excellent marker.

Eponides mexicana (Cushman) Pl. 2, figs. 6, 7, 8.

Pulvinulina mexicana Cushman, Bull. Amer. Assoc. Petrol. Geol., vol. 9, No. 2, p. 300, pl. 7, figs. 7, 8, 1925.

Eponides mexicana (Cushman), Jour. of Pal., vol. 1, No. 2, p. 165, pl. 26, figs. 6, 7, 1927.

Numerous specimens of the species occur, particularly in the bottom sample. It is another characteristic foraminifera confined to the Guayabal and should prove to be an excellent horizon marker.

Genus ROTALIA Lamarck, 1804.

Rotalia dorri n. sp. Pl. 4, figs. 5, 6.

Test bi-convex, umbilicate tightly coiled; ventral side more convex than the dorsal; two and one-half coils with 8-9 gradually enlarging chambers in the last formed coil;

margin rounded; aperture an arched slit on the last septal face, midway between the dorsal margin and the umbilicus.

Diameter 0.35-0.75 mm.

This is a distinct species found in great numbers in the lower sample from the type locality. It seems to be confined to the Guayabal and is an excellent marker for certain horizons. This species is named in honor of Mr. James B. Dorr, Paleontologist of the Huasteca Petroleum Company, Tampico, Mexico.

Subfamily SIPHONININÆ

Genus EPISTOMINA Terquem, 1883

Epistomina bradyi Galloway and Wissler Pl. 2, figs. 1, 2.

Pulvinulina partschiana H. B. Brady (d'Orbigny), Rept. Challenger, Zool., vol. 9, p. 699, pl. 105, fig. 3, 1884.

Epistomina bradyi Galloway and Wissler, Jour. of Pal., vol. 1, No. 1, pp. 60-61, pl. 10, fig. 1, 1927.

Several specimens of the same character as the one described by Galloway and Wissler occur in the Guayabal sample. It is not very distinctive and probably of no stratigraphic value as similar species occur in other Mexican formations. Cushman considers the specimens he has from the Alazan as *Epistomina elegans* (d'Orbigny). However, the Guayabal specimens agree more closely to Brady's and Galloway's figures, than to those usually referred to as *E. elegans*.

Genus SIPHONINA Reuss, 1849

Siphonina tenuicarinata Cushman Pl. 5, figs. 1, 2.

Siphonina tenuicarinata Cushman, Jour. of Pal., vol. 1, No. 2, pp. 166-167, pl. 26, figs. 11, 12, 1927.

The Guayabal specimens resemble the Alazan species as described by Cushman very closely. I have compared actual specimens and the only difference noted is that the wide keel is missing frequently in the Guayabal forms. Many Alazan specimens also seem to be lacking the keel. As the chambers and other features of the test remain constant and similar, I am referring the Guayabal specimens to his species. This is one of the long ranged foraminifera in the Mexican formations.

Family AMPHISTEGINIDÆ

Genus AMPHISTEGINA d'Orbigny, 1826

Amphistegina mexicana n. sp.

Pl. 2, fig. 18.

Test small, lenticular or more convex on the ventral side in some specimens; 24-26 chambers composing the last formed volution which embraces all the preceding ones; sutures distinct, particularly in older specimens where they are slightly raised, straight for half their length, after which they are strongly recurved; the area near the aperture slightly papillate.

Diameter 1.06-1.60 mm.

Family CASSIDULINIDÆ

Subfamily CERATOBULIMININÆ

Genus CERATOBULIMINA Toulà, 1920

Ceratobulimina declivis Reuss, var. *mexicana*

Pl. 5, fig. 16.

The variety differs from the original in its more compact form, less prominent sutures and less inflated chambers.

Length 0.42 mm.

This is a very rare species in the Guayabal and as far as I know, does not occur in any other Mexican formation.

Genus PULVINULINELLA Cushman, 1926

Pulvinulinella culter (Parker and Jones), var. *mexicana* n. sp.

Pl. 1, figs. 15, 16.

The variety differs from the typical form in its larger size, narrow flange, less pronounced, ventral sutures, greater bi-convexity and very smooth, glassy, dorsal surface.

Diameter 0.75-0.95 mm.

Specimens are relatively rare, but from observations on other formations, this variety probably ranges through most of the Eocene formations in Mexico, at least up to the Alazan. It is related to *Pulvinulinella interrupta* Cushman from the Alazan and *Pulvinulinella velascoensis* (Cushman) from the Velasco. It is intermediate between these two types.

Subfamily CASSIDULININÆ

Genus CASSIDULINA d'Orbigny, 1826

Cassidulina globosa Hantken

Cassidulina globosa Hantken, A magy. kir. foldt. in. eukonyve., vol. 4, p. 54, pl. 16, fig. 2, 1875 (1876).

Cassidulina globosa Hantken, Mitth. Jahrb. ungar. geol. Anstalt., vol. 4, p. 64, pl. 16, fig. 2, 1875 (1881).

Cassidulina globosa Cushman, Jour. of Pal., vol. 1, No. 2, p. 167, pl. 26, fig. 13, 1927.

A species occurring very infrequently, may be referred to the one described by Hantken. It is a long ranged foraminifera in the Mexican formations and therefore, of no stratigraphic importance.

Cassidulina lomitensis Galloway and Wissler, var. *mexicana* n. var. Pl. 5, figs. 4, 5.

This variety differs from the typical form mainly in size and thickness. Specimens of this variety while coiling exactly as the Californian species and having the same shaped aperture, are constant in their much smaller size.

Diameter 0.21 mm. Thickness 0.11 mm.

It is a rare form in the Guayabal and easily overlooked on account of its small size.

Family CHILOSTOMELLIDÆ

Subfamily ALLOMORPHINELLINÆ

Genus PULLENIA Parker and Jones, 1862

Pullenia quinqueloba (Reuss)

Pl. 5, fig. 15.

Nonionina quinqueloba Reuss, Zeitschr. deutsch. geol. Ges., vol. 3, p. 47, pl. 5, figs. 31a, b, 1851.

Pullenia quinqueloba Cushman, Bull. U. S. Nat. Mus., No. 100, vol. 4, p. 299, 1921.

Small, five chambered specimens of this genus which may be referred to Reuss' species, are found very rarely in the Guayabal material.

Family GLOBIGERINIDÆ

Subfamily GLOBIGERININÆ

Genus GLCBIGERINA d'Orbigny, 1826

Globigerina apertura Cushman

Globigerina apertura Cushman, Bull. U. S. Geol. Survey, No. 676, p. 57, pl. 12, fig. 8, 1918.

Globigerina apertura Galloway and Wissler, Jour. of Pal., vol. 1, No. 1, p. 40, pl. 7, fig. 5, 1927.

Frequent specimens of *Globigerina* that resemble Cushman's species very closely, are found in the Guayabal. So far, this is the lowest record for this species.

***Globigerina bakeri* n. sp.**

Pl. 4, figs. 12, 13.

Test large, composed of four, inflated chambers in the last volution; initial chambers small, usually five in number, tightly coiled; wall coarsely punctate; one main aperture and several smaller ones opening into the shallow umbilicus.

Diameter 0.63 mm.

This large, subglobular species is one of the commonest of the *Globigerina* forms encountered in the Guayabal. It is named in honor of Mr. William Baker, Geologist of the Trans-continental Petroleum Company, Tampico, Mexico.

***Globigerina orbiformis* n. sp.**

Pl. 5, fig. 7.

Test small, spherical; sutures in most specimens very indistinct; chambers slightly if at all inflated; wall thick, reticulate; surface dull; one, main aperture at the base of the last formed chamber with several, smaller apertures.

Diameter 0.27 mm.

This small species is evidently the ancestor of *Globigerina mexicana*, found in the first eighty feet of the formation above. It differs from the latter mainly in its constantly smaller size and rougher finish.

***Globigerina inflata* d'Orbigny**

Pl. 4, fig. 19.

Globigerina inflata d'Orbigny, His. Nat. Isles Canaries., vol. 2, pt. 2, Forams. p. 134, pl. 2, figs. 7-9, 1839.

Globigerina inflata H. B. Brady, Rept. Challenger. Zool., vol. 9, p. 601, pl. 79, figs. 8-10, 1884.

Globigerina inflata Galloway and Wissler, Jour. of Pal., vol. 1, No. 1, p. 43, pl. 8, fig. 1, 1927.

One of the most common *Globigerina* in the Guayabal, may be referred to this species. It is relatively abundant at all horizons and has a long range.

***Globigerina topilensis* Cushman**

Globigerina topilensis Cushman, Cont. Cushman Lab. Foram. Res., vol. 1, No. 1, p. 7, pl. 1, figs. 9a, b, c, 1925.

Cushman described this species from the Upper Eocene,

Tantoyuca formation. It is relatively common in the Guayabal formation. Probably it occurs only rarely in the Tantoyuca, as I have never seen any specimens in that formation in the samples from the type locality of the Tantoyuca.

Globigerina wilsoni

Pl. 4, figs. 8, 9.

Test slightly rotaliform, almost planospirally coiled, last volution consisting of five gradually enlarging chambers; umbilicate; wall coarsely perforate; aperture a curved slit opening into the umbilicus.

Diameter 0.24 mm.

This species is very similar to one figured by Mrs. Plummer from the Midway of Texas as *G. pseudo-bulloides*. It differs in having a less lobate periphery and in being more planospirally coiled. Due to its small size, it is often overlooked in the Guayabal. It is named in honor of Mr. John H. Wilson, Geologist of the Huasteca Petroleum Company, Tampico, Mexico.

Family GLOBOROTALIIDÆ

Genus GLOBOROTALIA Cushman, 1927

***Globorotalia crassata* (Cushman)**

Pl. 1, figs. 7, 8.

Pulvinulina crassata Cushman, Bull. Amer. Assoc. Petrol. Geol., vol. 9, No. 2, pp. 300-301, pl. 7, fig. 4, 1925.

This species described by Cushman, is another abundant form at the type locality of the Guayabal. Associated with it is the var. *densa*, also abundant. These forms range through the entire Guayabal and probably into the formation below the Guayabal.

***Globorotalia spinulosa* Cushman**

Pl. 2, fig. 9.

Globorotalia spinulosa Cushman, Cont. Cushman's Lab. Foram. Res., vol. 3, pt. 2, p. 114, pl. 23, figs. 4a-c, 1927.

This is a long ranged species in the Eocene of Mexico, extending from the un-named formation below the Tempoal into the Chapapote. It is constant in its characters throughout its range.

Family ANOMALINIDÆ

Subfamily ANOMALININÆ

Genus ANOMALINA d'Orbigny, 1822

***Anomalina umbonata* Cushman**

Anomalina umbonata Cushman, Bull. Amer. Assoc. Petrol. Geol., vol. 9, No. 2, p. 300, pl. 7, figs. 5, 6, 1925.

Anomalina umbonata Cushman, Jour. of Pal., vol. 1, No. 2, p. 170, pl. 27, figs. 10, 11, 1927.

Specimens of this striking *Anomalina* are met with frequently in all samples. It is very true to type as described from the Moctezuma river.

Subfamily CIBICIDINÆ

Genus CIBICIDES Montfort, 1808

***Cibicides conoideus* Galloway and Wissler** Pl. 2, figs. 3, 4, 5.

Cibicides conoideus Galloway and Wissler, Jour. of Pal., vol. 1, No. 1, pp. 63, 64, pl. 10, fig. 7, 1927.

There are specimens in the Guayabal of a small *Cibicides*, that agree almost exactly with the one described by Galloway and Wissler. The only difference is, that the Guayabal species characteristically has sixteen chambers. Until actual specimens can be compared, it is better to refer the Guayabal specimens to this species. The umbonate character of these specimens is particularly striking, as is the case with Galloway's species.

***Cibicides sassei* n. sp.**

Pl. 4, figs. 10, 11.

Test bi-convex, more strongly so on the ventral side; the final volution composed of nine, gradually enlarging chambers, the final one often inflated more than the others; periphery subangulate, subcarinate; shell coarsely perforate; a knob of clear shell material occupying the center on the ventral side; sutures distinct, of clear shell material, on the dorsal side, slightly raised as they approach the center and joining to form a mass of shell material; aperture on the periphery at the base of the last chamber and extending on to the dorsal along the suture line, between the last two whorls for a distance of one chamber.

Diameter 0.39 mm. Thickness 0.15 mm.

This is a common fossil at many horizons. It is named in honor of Mr. Jerome B. Sasse, Paleontologist of the Huasteca Petroleum Company, Tampico, Mexico.

Cibicides pseudowuellerstorfi n. sp.

Pl. 1, figs. 13, 14.

Test plano-convex, very flat dorsally, slightly convex ventrally; last formed coil composed of 10-12 chambers; periphery very slightly lobate, bluntly angulate, slightly carinate; sutures gently curved, limbate; wall coarsely punctate; all the chambers showing dorsally, only those of the last formed whorl ventrally; the umbilical region with a large knob of clear shell material; aperture peripheral, extending on to the dorsal side.

Diameter 0.66 mm.

Dorsally, this heavy ribbed *Cibicides* resembles *C. wuellerstorfi*, but the knob of clear shell material and gently recurved sutures easily distinguish it from this species. It is a relatively common form in the Guayabal and is confined to that formation.

Family ORBITOIDIDÆ

Genus DISCOCYCLINA Gumbel, 1868

Discocyclina clarki (Cushman)

Pl. 2, fig. 32.

Orthophragmina clarki Cushman, U. S. Geol. Survey, Prof. Paper, No. 125, pp. 41, 42, pl. 7, figs. 4, 5, 1919.

Except for size, this species agrees exactly with the description and figures given by Cushman. The largest specimens from the Guayabal, measures slightly under 3 mm.

It is characteristic particularly of the lower samples from the type locality where it is abundant. It occurs rarely in the other samples and apparently is short-ranged.

PLATES 1-5

Note.—All the holotypes described and figured in this paper have been deposited in the Eocene collection of Prof. G. D. Harris at Cornell University.

All the specimens described came from the Guayabal type locality.

PLATE 1

FIGURE	PAGE
1. <i>Bulimina guayabalensis</i> n. sp. x 75; holotype.....	24
2. <i>Bulimina guayabalensis</i> n. sp. x 75; paratype.....	24
3. <i>Lenticulina guayabalensis</i> n. sp.; apertural view x 40; paratype	14
4. <i>Lenticulina guayabalensis</i> n. sp.; side view of a larger speci- men x 40; holotype.....	14
5. <i>Robulus pseudocultratus</i> n. sp. x 35; holotype.....	19
6. <i>Polymorphina communis</i> d'Orbigny x 45.....	21
7. <i>Globorotalia crassata</i> (Cushman); dorsal view x 35.....	34
8. <i>Globorotalia crassata</i> (Cushman); ventral view x 35.....	34
9. <i>Lingulina mexicana</i> n. sp. x 40; holotype.....	19
10. <i>Vulvulina</i> cf. <i>spinosa</i> Cushman x 30.....	12
11. <i>Clavulina guayabalensis</i> n. sp. x 40; holotype.....	13
12. <i>Robulus pseudovortex</i> n. sp. x 40; holotype.....	19
13. <i>Cibicides pseudowuellerstorfi</i> n. sp.; dorsal view x 40; holotype	36
14. <i>Cibicides pseudowuellerstorfi</i> n. sp.; view of a slightly small- er specimen x 40; paratype.....	36
15. <i>Pulvinulinella culter</i> (Parker and Jones) var. <i>mexicana</i> n. var.; ventral view x 30; holotype.....	31
16. <i>Pulvinulinella culter</i> (Parker and Jones) var. <i>mexicana</i> n. var.; dorsal view x 30; paratype.....	31
17. <i>Lenticulina theta</i> n. sp. x 40; holotype.....	14
18. <i>Robulus articulatus</i> (Reuss) x 40.....	18
19. <i>Proroporus mexicanus</i> n. sp. x 40; holotype.....	26
20. <i>Robulus mexicanus</i> (Cushman) x 35.....	18
21. <i>Nodosaria</i> sp. x 30.....	17

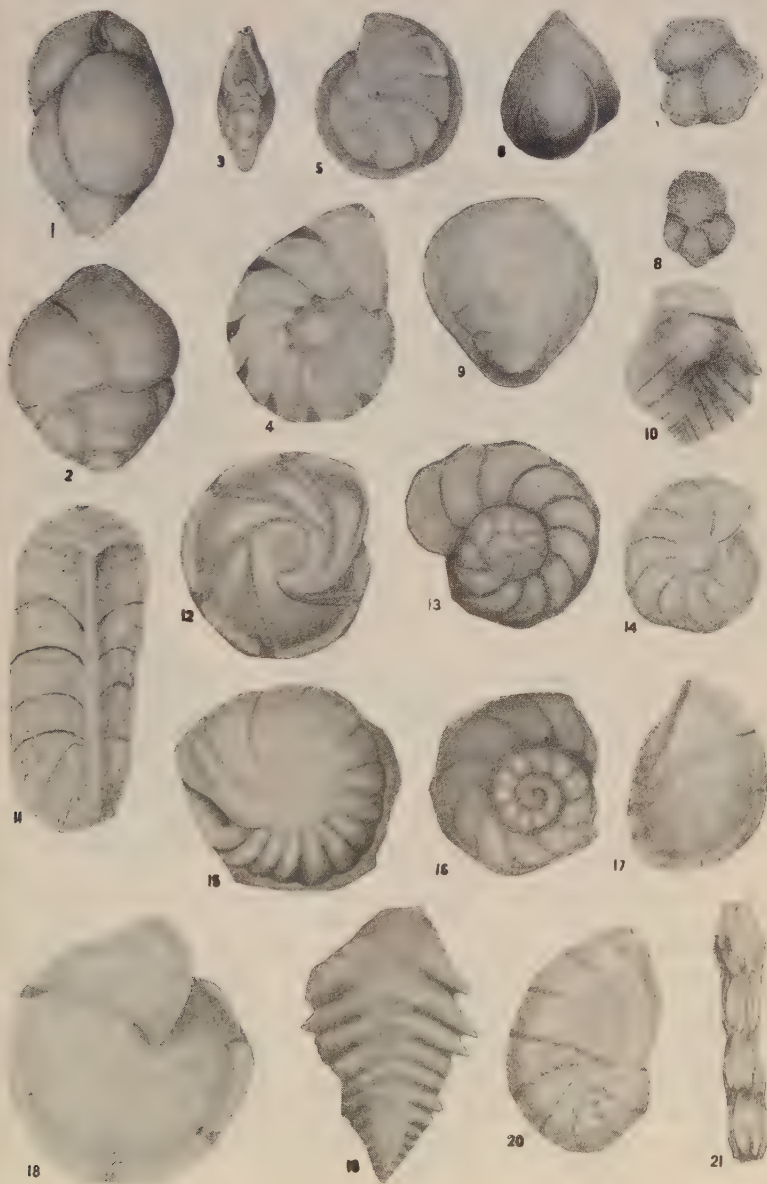


PLATE 2

FIGURE	PAGE
1. <i>Epistomina bradyi</i> Galloway and Wissler; ventral view x 15	30
2. <i>Epistomina bradyi</i> Galloway and Wissler; dorsal view x 15.	30
3. <i>Cibicides conoideus</i> Galloway and Wissler; ventral view x 35.	35
4. <i>Cibicides conoideus</i> Galloway and Wissler; dorsal view of a larger specimen x 35.....	35
5. <i>Cibicides conoideus</i> Galloway and Wissler; side view x 35.	35
6. <i>Eponides mexicana</i> (Cushman); ventral view x 45.....	29
7. <i>Eponides mexicana</i> (Cushman); side view x 45.....	29
8. <i>Eponides mexicana</i> (Cushman); dorsal view x 45.....	29
9. <i>Globorotalia spinulosa</i> Cushman; ventral view x 35.....	34
10. <i>Plectofrondicularia</i> sp. x 23.....	24
11. <i>Nonion turgidus</i> (Williamson), var. <i>mexicanus</i> n. var. x 65; holotype	23
12. <i>Amphistegina mexicana</i> n. sp. x 35; holotype.....	31
13. <i>Operculina cushmani</i> n. sp. x 14; holotype.....	23
14. <i>Uvigerina blanca-costata</i> n. sp. x 55; holotype.....	26
15. <i>Vaginulina costifera</i> n. sp. x 32; holotype.....	20
16. <i>Uvigerina rippensis</i> n. sp. x 27; holotype.....	27
17. <i>Eponides guayabalensis</i> n. sp.; ventral view x 25; paratype..	29
18. <i>Eponides guayabalensis</i> n. sp.; dorsal view x 25; holotype....	29
19. <i>Eponides guayabalensis</i> n. sp.; side view x 25; paratype.....	29
20. <i>Operculina bartschi</i> Cushman, var. <i>plana</i> Cushman x 14.....	23
21. <i>Gyroidina soldanii</i> d'Orbigny, var. <i>octocamerata</i> Cushman and G. D. Hanna; side view x 45.....	29
22. <i>Gyroidina soldanii</i> d'Orbigny var. <i>octocamerata</i> Cushman and G. D. Hanna; ventral view x 45.....	29
23. <i>Gyroidina soldanii</i> d'Orbigny, var. <i>octocamerata</i> Cushman and G. D. Hanna; dorsal view x 45.....	29
24. <i>Gyroidina guayabalensis</i> n. sp.; side view x 40; paratype.....	28
25. <i>Gyroidina guayabalensis</i> n. sp.; ventral view x 40; holotype..	28
26. <i>Gyroidina guayabalensis</i> n. sp.; dorsal view x 40; paratype..	28
27. <i>Quinqueloculina hermosa</i> n. sp. x 47; holotype.....	13
28. <i>Quinqueloculina hermosa</i> n. sp. x 47; paratype.....	13
29. <i>Gaudryina gaudryinoides</i> (Fornasini) x 30.....	13
30. <i>Verneuilina palmeræ</i> n. sp. x 45; holotype.....	12
31. <i>Discocyclina clarki</i> (Cushman) x 14.....	36

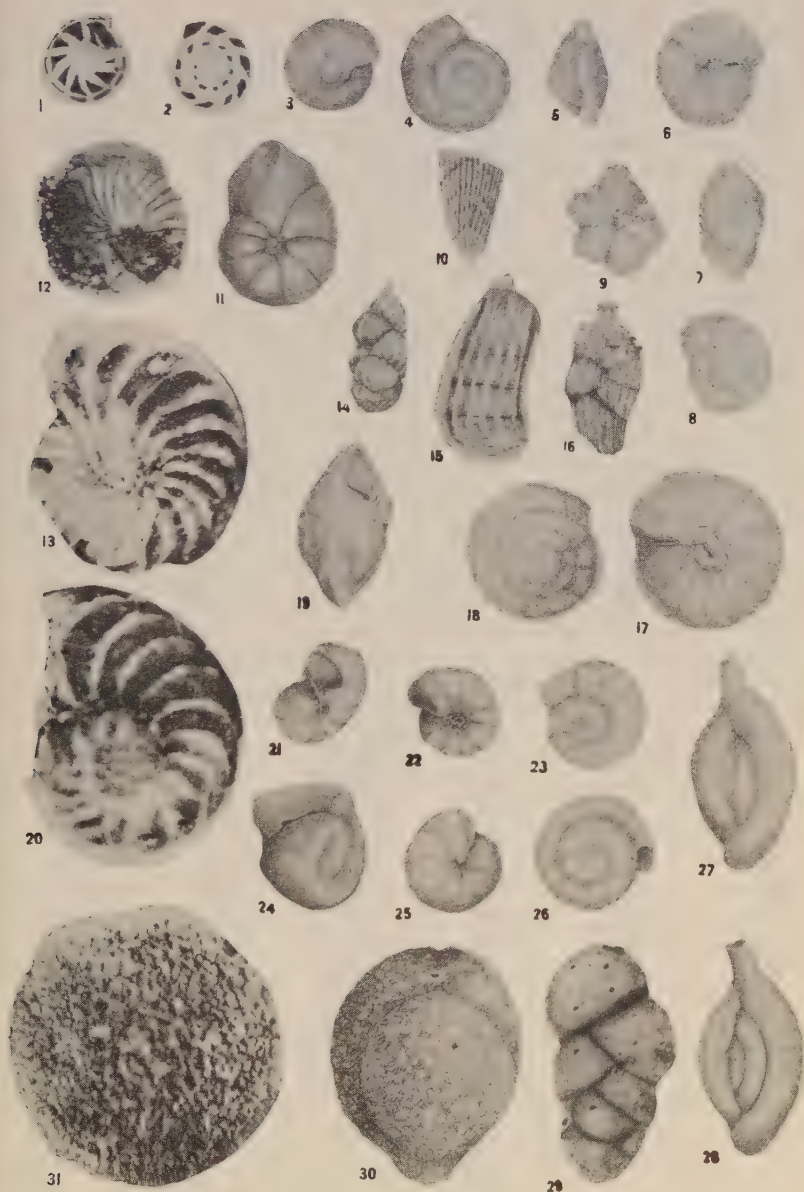


PLATE 3

1. <i>Dentalina pulchrella</i> n. sp. x 90; holotype.....	15
2. <i>Nodosaria harrisi</i> n. sp. x 80; holotype.....	16
3. <i>Nodosaria mexicana</i> Cushman x 30.....	16
4. <i>Nodosaria mexicana</i> Cushman; view of another specimen x 30.	16
5. <i>Nodosaria consobrina</i> d'Orbigny x 30.....	15
6. <i>Glandulina radícula</i> (Linnaeus); constricted form x 60.....	17
7. <i>Glandulina radícula</i> (Linnaeus) x 60.....	17
8. <i>Nodosaria wegemanni</i> n. sp. x 50; holotype.....	17
9. <i>Nodosaria cocoaensis</i> Cushman, var. <i>mexicana</i> n. var. x 25; holotype	15
10. <i>Vaginulina legumen</i> (Linnaeus), var. <i>elegans</i> d'Orbigny x 30	21
11. <i>Vaginulina legumen</i> (Linnaeus), var. <i>elegans</i> d'Orbigny; view of another specimen x 30.....	21
12. <i>Bulimina cf. inflata</i> Seguenza x 75.....	25
13. <i>Vaginulina wrighti</i> n. sp. x 95; holotype.....	21
14. <i>Dentalina cucarensis</i> n. sp. x 85; holotype.....	14
15. <i>Nodosaria cf. granti</i> Plummer x 30.....	15
16. <i>Nodosaria oolinata</i> n. sp. x 90; holotype.....	16
17. <i>Nodosaria</i> sp. x 30.....	17



PLATE 4

FIGURE	PAGE
1. <i>Robulus alato-limbatus</i> (Gumbel) x 20.....	18
2. <i>Uvigerina elongata</i> n. sp. x 55; holotype.....	26
3. <i>Uvigerina elongata</i> n. sp.; different specimen from fig. 2 x 55; paratype	26
4. <i>Nonion florinensis</i> n. sp. x 85; holotype.....	22
5. <i>Rotalia dorri</i> n. sp., apertural view x 24; holotype.....	29
6. <i>Rotalia dorri</i> n. sp.; dorsal view x 24; paratype.....	29
7. <i>Hantkenina longispina</i> Cushman x 55.....	24
8. <i>Globigerina wilsoni</i> n. sp.; dorsal view x 80; holotype.....	34
9. <i>Globigerina wilsoni</i> n. sp.; ventral view x 80; paratype.....	34
10. <i>Cibicides sassey</i> n. sp.; dorsal view x 70; holotype.....	35
11. <i>Cibicides sassey</i> n. sp.; apertural view x 70; holotype.....	35
12. <i>Globigerina bakeri</i> n. sp. x 25; holotype.....	33
13. <i>Globigerina bakeri</i> n. sp.; different specimen from fig. 12 x 25; paratype.....	33
14. <i>Trochamminoides guayabalensis</i> n. sp. x 75; holotype.....	11
15. <i>Pyrgo</i> sp. x 80.....	13
16. <i>Globulina gibba</i> d'Orbigny x 85.....	21
17. <i>Ammodiscus incertus</i> d'Orbigny x 27.....	10
18. <i>Verneuilina</i> aff. <i>triquetra</i> (Munster) x 75.....	12
19. <i>Globigerina inflata</i> d'Orbigny; ventral view x 85.....	33
20. <i>Guttulina problema</i> d'Orbigny x 60.....	22

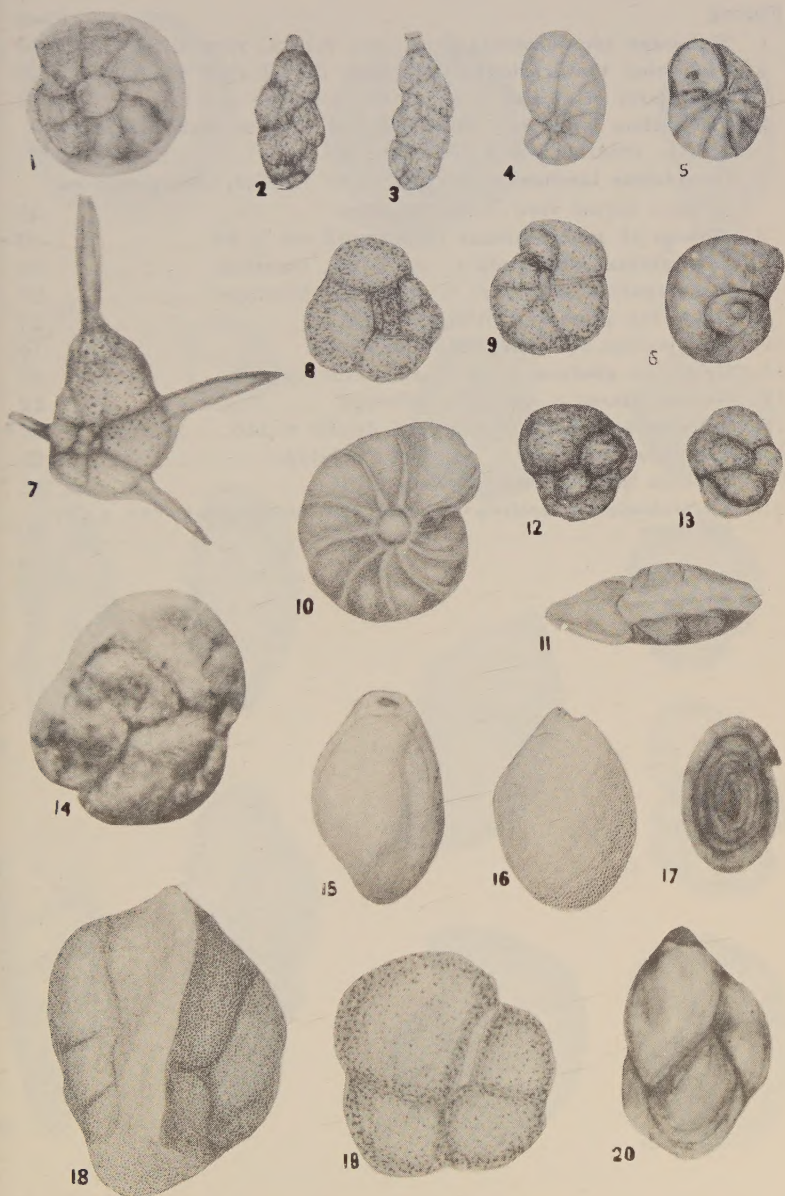


PLATE 5

FIGURE	PAGE
1. <i>Siphonina tenuicarinata</i> Cushman; ventral view x 60.....	30
2. <i>Siphonina tenuicarinata</i> Cushman; dorsal view x 60.....	30
3. <i>Textularia mexicana</i> n. sp. x 55; holotype.....	11
4. <i>Cassidulina lomitensis</i> Galloway and Wissler, var. <i>mexicana</i> n. var., ventral view x 75; holotype.....	32
5. <i>Cassidulina lomitensis</i> Galloway and Wissler, var. <i>mexicana</i> n. var.; dorsal view x 75; paratype.....	32
6. <i>Nonion cf. umbilicatululus</i> (Montagu) var. x 60.....	23
7. <i>Globigerina orbiformis</i> n. sp. x 65; holotype.....	33
8. <i>Angulogerina gallowayi</i> n. sp. x 90; holotype.....	28
9. <i>Uvigerina pigmea</i> d'Orbigny x 85.....	27
10. <i>Marginulina subbullata</i> Hantken x 85.....	14
11. <i>Uvigerina gladysæ</i> n. sp. x 150; holotype.....	27
12. <i>Nonion micrus</i> n. sp. x 95; holotype.....	22
13. <i>Boliyina gracilis</i> Cushman and Applin x 140.....	26
14. <i>Virgulina mexicana</i> n. sp. x 85; holotype.....	25
15. <i>Pullenia quinqueloba</i> (Reuss) x 130.....	32
16. <i>Ceratobulimina declivis</i> (Reuss), var. <i>mexicana</i> n. var. x 75; holotype	31

